$|z_j|$ of the poles of Q. Then the best choice of the tuning parameters is such that the max $\{|z_1|, |z_2|, \ldots, |z_j|\}$ is minimized, i.e., the best tuning parameters form a solution to the following minimax problem:

$$\min \max \{|z_1|, |z_2|, \ldots, |z_j|\}$$

In situations where one or more of the tuning parameters must be within user specified regions, the above minimax problem becomes a constrained minimax problem.

Many commercially available software products can directly be used to find the poles of a transfer function and the roots of a polynomial, and to solve the minimax or constrained minimax problem as formulated above, such as (1) the function "pole" in the "Control System Toolbox", which can find the poles directly from the transfer function Q, (2) the function "roots" in MATALAB, which can directly find the roots of the characteristic equation b(z)=0, and (3) the functions "minimax" and "fminimax" in the "Optimization Toolbox", which directly provides solution to the constrained or unconstrained minimax problem formulated above, all of which are easy to use and commercially available from The MathWorks Inc.

<u>In the Claims</u>

Please cancel claims 1 to 15 and substitute new claims 16 to 21 as follows:

16 A method for determining the optimal tuning parameters in a linear controller, wherein

a) the said linear controller is a device that receives an n-dimensional process variable y(t) from a process and sends an n-dimensional controller output signal u(t) to the said process, where t is the time variable and n is a positive integer,

b) the said linear controller uses the following type of linear difference equation to calculate the controller output u_k

$$Du_k=Er_k-Cy_k$$

where $y_k=y(t_k)$ is the process variable at time $t_k=t_0+kT_s$, t_0 is the initial time, $T_s>0$ is the constant sampling period, k is a non-negative integer called discrete time variable, $u_k=u(t_k)$ is the controller output at time t_k, and u_k can be subject to lower limit and/or upper limit constraints placed on one or more of its components, $r_k=r(t_k)$ is the set point at time t_k, D, E and C are n by n matrix polynomials in the unit backward shifting operator z^{-1} such that for any discrete time signal x_k, $z^{-1}x_k=x_{k-1}$, and one or more of the said D, E and C contain tuning parameters that are to be determined,

c) the discrete time open-loop transfer function of the said process from the said controller output u_k to the said process variable y_k is $A^{-1}B$, where A and B are known n by n matrix polynomials in the unit backward shifting operator z^{-1}, and

d) the said method finds the optimal values for the said tuning parameters by minimizing the maximum of absolute values of all poles of the discrete time closed-loop transfer function $(A+BD^{-1}C)^{-1}BD^{-1}E$ from the said set point r_k to the said process variable y_k.

17 A method as in Claim 16, wherein the said minimization of the maximum of absolute values of all poles of the closed loop transfer function $(A+BD^{-1}C)^{-1}BD^{-1}E$ from the said set point r_k to the said process variable y_k is subject to constraints placed on the said tuning parameters